ice formed, since most of these flights were made before daylight and the ice usually was melted by the time the plane reached the ground. Also, there is a certain amount of confusion in the minds of many as to what constitutes rime and what clear ice. It is hoped that the descriptions given in the paper will make possible a more accurate classification in this respect in future observations. It is believed, however, that so far as averages are concerned, the values found would not change appreciably with additional observational data.

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THE SECTION DIRECTOR AND THE COOPERATIVE OBSERVER[1]

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I have chosen as the title of the paper, "The Section Director and the Cooperative Observer." This title would seem to involve practically all the activities of the Climatological Service, and probably nearly all of them will be touched upon in some part of the paper in the hope that some of my experiences and possibly some of the methods of handling the work at Huron may prove helpful to other section directors. There is also the hope that in the discussion to follow some things will be brought out that will be helpful to me. However, it will deal mainly with matters pertaining particularly to the personnel.

It seems to me that the most important functions performed by the Weather Bureau, next to that of making and disseminating forecasts and warnings, is that of securing a climatological history of the country. The aim of each section director, to voice a thought which, doubtless, every one of them has before him at all times, should be to make this history as exact and reliable as possible. In the aggregate, large interests are involved in this connection. Court decisions and the friendly settlement of damage claims are often determined by the weather records. Whether climatic conditions are favorable or unfavorable for the type of farming in which prospective settlers contemplate engaging is shown largely by the climatological history obtained through the efforts of cooperative observers. This is true of all the country, but it is particularly true of the more sparsely settled States like South Dakota.

It is as much the duty of the Weather Bureau to show that climatic conditions are unfavorable when such is the case as it is to show that they are favorable. Also, in some instances, the practicability of carrying on other industries than farming is determined by the climatic conditions that prevail. That justice may prevail in court decisions and in the friendly settlement of differences; that the development of agriculture, particularly in new territory, may be along proper lines; and that the peculiar climatic conditions needed by certain lines of manufacture or other industry may be determined so that they need not be artificially produced, thus avoiding economic loss, reliable data are necessary. Thus a great responsibility rests upon the section director and, through him, on the cooperative observers. Careful and conscientious direction of the work of cooperative observers by the section director can bring valuable results, while lack of it may bring loss to those placing reliance on the accuracy of the data. The thing of first importance in the service, therefore, is to secure a corps of intelligent and reliable observers, men or women, who take a personal interest in making weather records and can be depended upon to make them trustworthy and to whom anything other than truth in their records would be odious.

In what class of persons can the most desirable observers be found? This is a question that is difficult to answer. Probably section directors have varying opinions regarding the matter, based, of course, upon their varying experiences. First of all I want to eliminate school-teachers. My experience is that they are undesirable. Their first purpose in acting as observers is to have the use of the equipment in teaching a small amount of meteorology to their science classes. This, in itself, of course, is good, but the purpose of maintaining the climatological service is to record climatological history, not to teach meteorology to high-school students. The teacher is apt to delegate the taking of observations to students, one at one time and another at another time, with undesirable results, for few of them comprehend the reasons for the work or care for it beyond getting by. Furthermore during vacation periods it is probable that no observations at all will be made.

It has been my experience that intelligent farmers of some education who possess a liking for noting and recording weather facts make excellent observers. Their personal interests are involved in securing a reliable climatological history of their localities. Also they are located out in the open where they can observe and make note of facts regarding the weather that are not so apparent to a man in town. If the equipment is properly placed on a farm, the data are less likely to be affected by local conditions than if the equipment is in town. When inspections are being made, some inconvenience is encountered and some additional expense is incurred if the station is in the country, particularly if the section director is traveling by train and not by automobile, and these facts deserve consideration. However, if a farmer who is acting as observer lives near town these considerations are minimized. On the whole I prefer farmer observers to any other class. When in need of a new observer my practice is to try to secure an intelligent farmer who lives near town and who is interested in that sort of thing. This is not to say that excellent observers are not found in other lines of employment. We have many excellent observers in South Dakota who are not farmers.

Probably every section director has, at some time or other, wished that cooperative observers were paid for their services so that pressure could be brought to bear on them to induce them to render prompt and complete reports. Doubtless, however, the attitude of the central office in this matter is wisest, for if no observer who is desirable because of his intelligence, reliability, and interest in the work can be secured without pay, the small compensation that could be given probably would not

[1] Invited paper presented before American Meteorological Society, Des Moines, Iowa, Dec. 28, 1929.

tempt him. The man who would act as observer for the few cents a day he would receive for his services and for that reason only, and who would have no other interest in the work, could not be depended upon to give the observations the careful attention they should have. Inaccuracies which he might believe would not be detected would mean nothing to him, while to the observer who does the work for love of it carelessness and inaccuracy would be repugnant. Probably every community has one or more persons who take pleasure in noting weather conditions and who would gladly act as observers, making excellent ones.

It seems to me that when a change of observers has become necessary or desirable the section director should visit the station, canvass the town and surrounding country carefully, and thus find the person best fitted to take over the work. This, of course, would be expensive, but it is my belief that the expense would be justified by the increased value of the climatological history secured. The data for cooperative stations, though less complete, should be as trustworthy as the data for the regular Weather Bureau stations. It can be made so only by the careful selection of observers. The expense would, partially if not wholly, be canceled by savings in other ways due to the operation of this plan. The total expense of the Weather Bureau for such visits and for inspection of stations might be reduced by visiting, en route, stations needing inspection. Also with observers thus carefully selected there would be less frequent need of inspection. Furthermore, it is probable that changes of observers would be less frequent than if they were secured through correspondence. The reliability of records, and consequently their value, that would be secured in this way would be greatly increased.

In connection with the expense of maintaining the climatological service the proportion of temperature and rainfall stations to rainfall stations should be given careful consideration. Temperature distribution is much more uniform than precipitation distribution. This is particularly true of level stretches of country such as make up the greater part of South Dakota. In mountainous regions, perhaps, this is not true. In those level stretches the number of rainfall stations should it seems to me, greatly exceed the number of temperature stations. Doubtless many temperature stations now in operation could be discontinued without loss, while an increase in the number of rainfall stations would enhance the value of the local record. The adoption of a policy along these lines would, doubtless, result in decreased expense of maintaining the entire service, since the cost of the equipment of a rainfall station is much less than that of a temperature station, while the replacement expense would be decidedly less.

I would be interested to learn how successful other section directors have been in getting observers to mail the booklets of Forms No. 1011 to the section center and how important they think it is that this should be done. Notwithstanding frequent requests to observers that they mail these booklets with Forms Nos. 1005 or 1009, I have seldom been able to have more than two-thirds of them sent in. In the interest of accuracy it seems to me that the data recorded in Form No. 1011 should be compared with the entries in Forms Nos. 1005 and 1009, and it is the practice of the Huron station to make this comparison. While the number of errors in copying that are detected is not great, it is great enough to make the comparison essential. The entire time required for this work at Huron does not exceed three hours a month for each of three persons.

Just as important as the accuracy of observations and of making a record of same is the accurate summarizing of the monthly reports, for the summarized values are those that come to the attention of the public. The practice in handling this work at the Huron station is as follows: First the data in Form No. 1011 are compared with the data entered in Forms Nos. 1005 and 1009. After this has been done the reports are checked for agreement between "Set Max." readings and maximum and minimum temperatures of the same day and of the following day, for precipitation entries or omissions that are obviously erroneous, and for agreement between precipitation entries and entries of snowfall and of notes that may appear on the form. This checking is done independently by two assistants or by one assistant and the official in charge. The maximum and minimum temperature, precipitation, and snowfall columns are then added on the adding machine from one copy of the report, and afterward the addition slips are compared with the other copy. When this has been done the means are computed by each of two persons. The reports are then summarized by one assistant and afterward carefully checked by the first assistant or the official in charge.

Delay in mailing reports in some instances by observers who, in other respects, are highly satisfactory is a source of annoyance. There are a few persistent offenders in this respect in South Dakota's corps of observers. When this is carried to the extent of practically nullifying the value of the station, there is, of course, nothing to be done but to change observers or to close the station. In South Dakota there are at least two of these offenders that are doing such excellent observational work that one hesitates to make a change, but continues to urge more prompt mailing of reports in the hope that they will finally acquire the habit of early mailing. I would be glad to learn in the discussion to follow what other section directors do in similar cases. Another heartbreaking experience is to have the services of an experienced, reliable, and faithful old observer terminated by death or for some other reason, after he has produced a recorded history covering many years and then to be unable to find a good observer to take his place. Such a station should not be permitted to die. Considerable expense to secure its continuance with the right kind of observer would be justified. The right man for the job might be found if the section director were to visit the station and make a careful survey of the possibilities.

How can correspondence best be handled so as to maintain cordial relations between section directors and cooperative observers. For the most part it is easy to write letters of instruction or letters calling attention to errors or to incorrect practices of observers in handling the work. It is only necessary for the section director to keep in mind the fact that observers are giving their services as such to the general public without financial compensation in order that he may be imbued with that feeling of appreciation that will, naturally, be given expression in the general tone of his letter. Indeed, an occasional letter of commendation is desirable and will be appreciated by observers. This should be a personal letter and not a circular letter, though there may be times when the latter would be effective. At all times correspondence should be characterized by the utmost courtesy and consideration. Not that observers resent criticism when criticism is justified and courteously offered. On the contrary, most of them will welcome criticism, rightly offered, that will lead to better results. Indeed, my experience has been that, in the rare instances where the services at a station have become decidedly

unsatisfactory, the observer will accept censure, when properly given without resentment and will try to improve his work. The temperaments and dispositions of observers should be carefully studied by the section director so that correspondence may be tempered to the individual and thus tie him more closely to the service in a friendly bond and build up the esprit de corps. Flattery is not needed, only frank friendliness and appreciation. It seems to me that the thing of greatest value in the inspection of cooperative stations is not to determine whether instruments are properly exposed and taken care of, for that can largely be done by correspondence, but rather the few hours of personal and intimate contact during which the section director and the observer can come to know each other and thus lay the foundation for continued friendly relations more firmly. Thus each may come to a better understanding of the problems of the other. Such understanding will lead to better results in the work and to greater satisfaction for both the section director and the observer in carrying it on.

In this paper I do not attempt to eulogize cooperative observers. I fear that I am unable to do justice to those unselfish individuals who, day after day and year after year, prompted by a desire to serve their fellow man, faithfully and conscientiously give their time and effort without financial compensation, and often, doubtless, at great inconvenience to themselves, to secure a reliable climatological history of their respective localities. I hope they feel that they have adequate reward in the consciousness of being good and faithful workers. The service performed by these men or women is not confined to taking and recording observations. They have many other calls upon their time in this connection. Many of them prepare weekly and monthly summaries of their data for the press. Occasionally one of them is called upon to take the records of his station into court. At all times, and particularly when unusual conditions prevail, he is subject to call from the people of his community for information as to temperature and precipitation. Also most of them prepare a weekly weather and crop report for the section center. This brings to me the thought that there is another group cooperating with the Weather Bureau that deserves commendation, namely, the weather and crop correspondents. A conscientious correspondent gives considerable time and thought to the preparation of his reports, and we have a few in South Dakota who make it their business to make long drives into the surrounding country to note crop conditions.

South Dakota has, perhaps, no observers who have served for such long periods as have a few observers in other sections, but she has many who have served long enough to be placed on a special honor roll. She has 18 observers who have served 20 or more years, 10 who have served more than 25 years, 9 who have served more than 30 years, 1 who has served 39 years, and one, Mr. D. G. Gallett, of Aberdeen, who has served 40 years. In making the above statement I have considered a family as one observer. Four of the above number fall into this class. Two sons, carrying on after the deaths of their fathers, and one widow after the death of her husband, have brought the total period of family service in each case to 33 years, and one son after the death of his father has brought the total period of family service to 39 years. These are records of which the makers of them can well be proud.

CONVENIENT METEOROLOGICAL RECORDS

By GEORGE B. WURTZ

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All business and professional activities require records, and in the light of experience these records should be in such form as readily to group themselves into classifications convenient for both comparison and summation.

Both in business and in our own professional work the time groups have logically arranged themselves into weekly and monthly periods. These two periods are not at present entirely commensurate; but, happily, it appears the time is not far distant when our international calendar conferences will make them so by adoption of the 4-week month, with 13 months to a calendar year.

In most of our work our records are arranged as nearly as practicable on the monthly basis and we customarily compute these in such time periods.

The last revision of our principal meteorological forms occurred about 28 years ago. At that time the committee handling the matter was somewhat divided on the size. The central office apparently adhered to the old size; the station representatives advocated one more conveniently slipped into the pocket, and especially convenient for use in court. With the present policy of taking the original records to court only when the certified compilations will not serve equally well, this necessity of convenience need not longer enter into the discussion. At that time, though compactness was urged, no change in size resulted, but the principal form, the present Form 1001, had added to it for station use Form 1014, to group daily data from a number of separate forms into a composite record on a single sheet for one day. For the study of several kinds of hourly data for a single period or not to exceed a single day, this is excellent; but for consideration of more extensive periods than a day, these records on Form 1014 are too extended and require more compact recompilation.

In all studies and compilations the monthly series on a single page is the more useful. The necessity for grouping arose not from the difficulty of consulting two or more data on separate pages but from the defective system of ruling the time lines on forms or having to obtain data from blurred press copies on flimsy tissues, often illegible and widely scattered in the files.

In making all forms of scale the mechanic's rule, the draughtsman's scale, the engineer's transit circles, diverse ruling is employed to avoid error. There is no reason why, in making our records, we should not employ the same efficient devices. In truth, in some forms we do; in others we do not.

It is a physiological fact that the eye comprehends readily no more than three things. It focuses on a single thing, as for instance, a line and takes in with less distinction the ones on either side, while the next in order farther away from the central point of focus begins to fade out into the borders of obscurity. When guide lines are marked in groups of five by inclosure with boundary lines of distinguishing size or color, the eye can place itself with fair accuracy amongst the seven, selecting any single one. Increase the number between the distinguishing guide lines to more than five and selection of any single line becomes chance.

In all rulings of date lines and time lines for hourly periods suitable subdivision rulings should be used in every instance. It has become universal in all accounting systems. It should be so, too, in ruling our record